# The Earth Science OIGEST

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MAY 1949

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# The Earth Science Digest

Revere, Massachusetts

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A magazine devoted to the geological sciences.

Jerome M. Eisenberg, Editor

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### CONTENTS

1949 Meetings and Conventions	2
State Geologists Hold Annual Meeting	2
Gold Panning Featured at Calif. Convention	2
COAL GEOLOGY—AN OPPORTUNITY FOR RESEARCH AND STUDY—Gilbert H. Cady	3
Coal Geology Laboratory to be Established	
THE EARTH SCIENCES — 1949: Krug Stresses Urgent Need for Conservation	
Alaskan Peninsula Is A Possible	11 12
Petroleum Source	
Aids Contour Mapping Close Inbreeding Possible Cause of	12
Rapid Elephant Evolution	13
Michigan Aeromagnetic Survey Released	13
New Geologic Map Series Initiated by U. S. G. S	14
"Earthquake Weather", Moon Eclipse, May Influence Tremors	14
Aftershocks Come When Earth Creeps Back After Tremor	14
Caves and Mines May Not Protect Against Bombs	15
Chile's Quake Was Deep-Focus Tremor of Major Intensity	15
ATOMIC ENERGY IN RELATION TO Geology — Sumner T. Pike	16
Colo. Uranium Ore Processing Plant to be Rehabilitated	18
NEW LIST OF GEOLOGIC MAP SYMBOLS PREPARED	19
Film on Peat-Moss Industry Released	19
Mineral Problems Discussed by	10
Mines Director	20
A. F. M. S. Sponsors Earth Science Contest	21
Annual Conclave of American Gem Society Held in Boston	22
NEW BOOKS	23

### COVER PHOTO

This month's cover photo is of gypsum "flowers" from Mammoth Cave National Park, Kentucky. Crystals of gypsum resembling rosettes, flowers, vines, etc., are often called "oulopholites" (from the Greek for "wooly" and "cave"). Photo courtesy of the National Park Service.

# 1949 MEETINGS AND CONVENTIONS

Eastern Section of the Seismological Society of America, Annual Meeting. June 10–11, 1949. Cambridge, Massachusetts.

San Fernando Valley Mineral & Gem Society, 6th Annual Display. June 11–12, 1949, North Hollywood, California.

Riverside County Chamber of Mines, 3rd Annual Gem and Mineral Show. June 16-19, 1949. Riverside, California.

American Federation of Mineralogical Societies, 2nd National Convention; California Federation of Mineralogical Societies, 10th Annual Convention. June 24–26, 1949. Sacramento, California.

Gem Village Annual "Rock Show." July 4, 1949. Gem Village, Bayfield, Colorado.

Fourth Empire Mining and Metallurgical Congress. July 9–23, 1949. London, England,

Rocky Mountain Federation of Mineral Societies, Annual Convention. August 25–27, 1949. Albuquerque, New Mexico.

Midwest Federation of Geological Societies, 9th Annual Convention. August 26–28, 1949. Davenport, Iowa.

Fourth International Conference on Quaternary Research. August 22—September 15, 1949. Budapest, Hungary.

Geological Society of America, 62nd Annual Meeting; Paleontological Society, 41st Annual Meeting; Mineralogical Society of America, 30th Annual Meeting; Society of Vertebrate Paleontology, 9th Annual Meeting. November 10–12, 1949. El Paso, Texas.

# STATE GEOLOGISTS HOLD ANNUAL MEETING

The annual meeting of the Association of American State Geologists was held at the offices of the California State Division of Mines in San Francisco, February 11–12, 1949.

Among the topics discussed were: the relation of the Association to federal government bureaus; State surveys and water resources investigations; marketing and utilization of minerals; Federal-State cooperative mapping projects; mine map repositories; well cuttings laboratory; and policies connected with the Journal of the Association of American State Geologists.

A field trip was conducted to selected parts of the Berkeley Hills, the San Andreas rift zone, and other areas of geologic interest.

### CALIF. CONVENTION FEATURES GOLD PANNING CONTEST

A gold panning contest will be featured at the 2nd National Convention of the American Federation of Mineralogical Societies, to be held at Sacramento, California. June 24-26, 1949. All the contestants will be dressed as "Forty-Niners". Every visitor from out of the State of California will be presented with a collection of California minerals. A number of extensive fluorescent mineral collections will be displayed, including that of Ultra Violet Products, Inc., one of the most spectacular in the country. For further information on the convention write to Jack G. Streeter, Convention Chairman. 6808 St. Estaban Street, Tujunga, California.

# **COAL GEOLOGY**

# An Opportunity For Research and Study.

GILBERT H. CADY

Chief of Coal Division - Illinois State Geological Survey

The nature of research in the geology of mineral substances varies among these substances. Conventional geological considerations are of prime importance, and research bearing on these considerations provides the fundamental knowledge that facilitates the discovery and recovery of ore deposits and water and oil resources.

With respect to coal the case is different. The problems of coal occurrence and distribution are solved by careful stratigraphic and mapping methods. Somewhat more exacting are those geological problems involved in the achievement of safe and easy recovery of the coal

But beyond all considerations involving occurrence, supply, and recovery of the coal resources is the fundamental geological problem of the character of the coal material itself, the solution of which is essential to the satisfactory classification and description and the effective and complete utilization of our coal resources.

### Nature of Coal Research

Coal geology may be conveniently partitioned into those fields of knowledge and inquiry that concern the geology of coal beds and those that concern the geology of the coal material itself. The

geology of coal beds consists of knowledge relating to the discovery and delineation of coal resources. the stratigraphic structural conditions, and geologic and economic conditions that affect the mining operation. The geology of coal material, on the other hand, consists of knowledge relating to the nature and origin of its physical heterogeneity in composition and properties, of its variations in chemical composition and properties, and of those geological conditions whereby these several variations were produced.

### Coal Resources Studies and Activities

Coal resource inventories require careful and detailed stratigraphic studies and mapping by technically trained geologists. The detailed stratigraphic succession of few, if any, of our American coal fields is thoroughly understood, thereby denving us complete understanding of the conditions of coal bed occurrence and origin. Furthermore, at many localities faulting and folding of the coal measures make necessary the skillful use of stratigraphic methods for the identification of coal beds. The growing usefulness of fossil spores obtained from coal beds by maceration methods is beginning to give the coal beds importance in their own right as stratigraphic key beds.

The mapping of coal resources commonly provides data for the construction of structure maps on one or more coal beds. Such maps

<sup>1—</sup>Published by permission of the Chief, Illinois State Geological Survey, Urbana.

Condensed from the article in ECON-OMIC GEOLOGY, Vol. 44, No. 1, Jan.-Feb., 1949.

have proved helpful not only for indicating the position and distribution of a particular coal bed, but also for indicating the nature and potency of the geological vicis-situdes to which the coal beds have been subjected. They also provide a plane of stratigraphic reference, and in oil and gas regions they may indicate the position of structures favorable for the accumulation of oil and gas.

Of much importance in fundamental studies is the information concerning the characteristics of coal beds and the relationship of coal beds to their associated strata. It would be a serious mistake to assume that all variations in coal bed characteristics are known and catalogued so long as large bodies of coal have not been carefully described.

Successful coal recovery requires an understanding of the characteristics of the strata above and below the coal bed being exploited. This is a phase of geology much neglected and too lightly regarded in academic geology curricula. Nor is this field of geology adequately supported by observational and experimental data.

There is also an almost complete lack of experimentally established data on the strength of rocks such



Illinois State Geological Survey

The Illinois State Geological Survey field laboratory for the logging of rotary drill holes to determine the position of workable coal beds.

as commonly compose the coal measures in various coal fields of this country.

The studies which must eventually be made to determine the forces that cause mine roof and floor failures will probably provide information about the nature and degree of the forces that cause the metamorphism of coal.

### The Natural History of Coal Beds

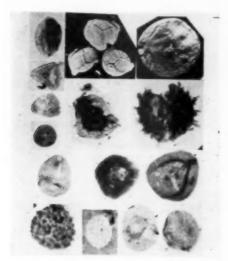
Coal geology would be incomplete without consideration of the origin of coal beds, the nature of the plants that contributed to the coal beds of various ages, the story of the events and conditions that favored plant growth, the preservation of plant debris in various degrees, and its burial and alteration to coal. An understanding of the natural history of a coal bed requires knowledge of the sedimentary conditions of the various strata associated with the coal beds and of the various biological and geological factors that effect plant disintegration on the one hand, and preservation, burial, and geological maturation on the other. It is desirable for early achievement of important and comprehensive results that the problem of coal bed origin be definitely correlated with problems related to coalification in general to avoid irrelevant investigations.

### Coal Constitution Studies

Closely related to the natural history of coal beds are studies in the constitution of coal that have been carried out in the field of coal botany, coal petrography, and coal chemistry. Such investigations have to do with the coal material and attempt to determine the physical properties and chemical and physical make-up of the coal.

### Studies in the Botanical Constitution of Coal

The possibilities of botanical research of various kinds in connection with the material present in beds are extensive. For example, recently the usefulness of spores as index fossils in the coal measures of Illinois has been explored (1) with promising results. Other resistant plant parts, such as cuticles, may have a similar stratigraphic use, but they are in general inherently less promising than spores.

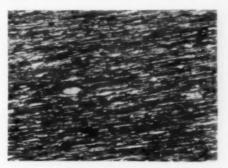


U. S. Bureau of Mines

Spore cases isolated from various coals, magnified about 250 times. Several show the characteristic triangular markings.

In some coal beds coal-balls are relatively common (2, 3) and these provide many well-preserved plant fossils representing the same kinds of plants that compose the coal beds but in uncompressed or only slightly compressed condition, so that the detailed structure of the coal-making plants can be readily discovered.

Botanical constitution of coal has for some time been regarded favorably as the key to and basis of variations in coal type, hence as



Illinois State Geological Survey

A thin section from a coal mine near Shelbyville, Illinois, showing an unusual number of spores. Magnification about 200 times.

of fundamental importance in determining the specific characteristics of coal as indicated by variations in physical properties, chemical composition, and in combustion, carbonization, and other behavior characteristics. Evidence seems to indicate that the rate and process of incoalation (coal formation) varies among the different classes of botanical substance contributing to the coal bed (4).

The importance of botanical research in coal is such as to merit the attention of a few geologists with botanical training or botanists with geological training. It is desirable to know all that can be learned of the botanical composition of coal. Only as the possibilities of variation in coal arising from variation in botanical constitution are realized can the effect of geological influences in coal formation and coal metamorphism be evaluated. Certain studies in the chemical constitution of coal may require much closer correlation with botanical data than has been generally achieved.

### Petrographic Method of Coal Description

The petrographic method of coal description, even in its present unsatisfactory technical status, owing to inexact and incomplete definition, has considerable usefulness as a tool of coal research in defining the physical characteristics of coal. The megascopic distinctions between different ingredients of the coal bed are valid, provided certain arbitrary, clearly defined standards of differentiation are observed. Detailed petrographic profiles of a coal bed in terms of the banded ingredients are useful in appraising its amenability to various preparation practices or to selective mining, in order to maintain a uniform product. It is believed that they have an importance comparable to that of chemical analyses of such cores.



Illinois State Geological Survey

The Illinois State Geological Survey Coal Division laboratory for the study of thin sections of coal, paleobotany, etc. Dr. James M. Schopf, now of the U. S. Geological Survey, is at the desk.

### **Chemical Constitution of Coal**

Elementary Analysis.—The oldest and simplest method of determining the composition of coal was by means of the elementary or ultimate analysis. In general this form of analysis provides, by direct determination, values for the amount of hydrogen and carbon in the combustible material composing coal, oxygen being a residue, the amount of which is determined by difference.

There is apparently a change in the relationship of carbon and hydrogen as coal advances from bituminous to anthracite rank, so that it is probable that anthracite and bituminous coal should be compared on some basis fundamentally different from that upon which comparison of two common types of bituminous coal is made. These relationships require investigation.

Commercial Type of Analysis.—
To meet commercial requirements there has been developed what is known as the "proximate" method of coal analysis. The proximate analysis when accompanied by determinations of sulphur content and of calorific value provides the standard criteria for differentiating coals of various ranks by the application of certain empirical rules. Such distinction is based upon samples representing the whole bed collected under standard conditions.

Chemical studies of the components of coal, the banded ingredients and the botanical entities using the methods of the ultimate and proximate analysis, although not neglected have not been adequate for providing a basis for sound judgment in regard to differences among the components.

It still remains to be determined whether or not even the proximate and ultimate forms of analysis might not reveal consistent and significant difference between varieties of coal selected to represent



Illinois State Geological Survey

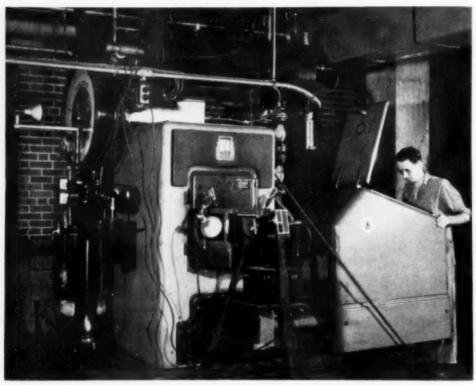
The Illinois State Geological Survey Coal Petrology laboratory for the study of the banded ingredient composition of broken coal in connection with their combustion investigations with a stoker-boiler combination. Mr. Bryan C. Parks, now with the U. S. Bureau of Mines, is at the table.

actual differences in the botanical or phyteral composition. This is a desirable field of investigation.

Organic Analysis.—The conventional methods of organic analysis have also been applied to coal to a rather limited extent. The usual procedure of analysis involves investigation of samples collected by standard methods of face sampling. Hence the sample, when the common banded type of coal is used, represents an average of a variety of organically different substances. Since most banded coal is predominantly humic in origin, the prevailing results will be very similar whatever coals were used, except for differences that might spring from variations in rank. It is not to be expected that the coal petrographer and coal botanist will be entirely satisfied with results obtained from analyses of such samples.

The various methods of analysis lead to the same general conclusions in regard to the aromatic nature of the coal material. Differences in these compounds appear to parallel progressive change in coal from rank to rank.

It may be pointed out that the main efforts of coal chemists have been directed not toward discovering the fundamental chemical differences in the materials composing the "coal conglomerate," but rather toward the determination of the nature of substances derived from coal when it is subjected to thermal decomposition. It seems



Illinois State Geological Survey

The stoker-boiler arrangement in the Applied Research laboratory of the Illinois State Geological Survey for testing the combustion characteristics of Illinois coals. Mr. R. J. Helfinstine, shown in the picture, has charge of this work for the Coal Division.

quite possible that the almost unlimited variety of materials present, at least potentially, in the liquid by-products of coke manufacture is partly responsible for the idea that the coal material itself is equally complex and varied, whereas complexity and variety in the by-products may be the result of the highly complex physical conditions accompanying heat treatment.

It is desirable to know more accurately the character of the initial source of these by-products and the extent to which the final complexity is the result of either initial complexity or physical heterogeneity. Such knowledge might also provide an answer to the un-

solved problem of the cause of the coking phenomenon.

### Fundamental Geological Research Into Coal Constitution

May not research in coal in the biological and chemical fields in general have failed to reach the desired objective of an understanding of the nature and constitution of coal largely because basic geological factors have been neglected? Geological considerations would seem to be of fundamental importance in any basic research in coal material because coal is a product of geological process of a fairly definite general character.

Geologists should regard basic research in the fundamental na-

ture of coal material as concerned primarily with a natural substance owing its existence and specific character to geological conditions. These conditions by reason of their progressive increase in severity produce coal from pre-coal material and subsequently alter coal through successive stages of increasing rank and ultimately change it to graphite. Geological processes bring about the chemical changes of coal formation and coal metamorphism and geologists should seek to determine both the nature of the geological influences that operate to change the organic materials and the reason for the specific changes produced.

Studies in coal resources and other studies relating to the physical and chemical constitution of coal such as have been suggested are essential preliminaries to fundamental coal research. Much more work along these lines needs to be done.

The conclusions reached by the organic chemist, through conventional analytical procedure, tend to focus attention upon the failure of such investigations to discover chemical reality in physical differences recognized by the coal petrographer and coal botanist. The relation of chemical variations in coal material should be related more specifically to the kind and degree of geological forces that produce rank variations in different kinds of coal material. A more substantial and easily traveled bridge must be laid between geological and chemical concepts relating to coal before complete correlation of ideas is possible. It is important that the geologists on their part explain more clearly the nature of the geological factors that have been involved in the formation and metamorphism of coal and that the chemists understand the nature and importance of geological processes in bringing about these changes, in other words to regard coal as a dynamic substance.

### Conclusion

A basis exists for more systematic education and training in the field of coal geology. Special attention is called to the need for basic research in coal, thereby providing a foundation for general academic activities in this field. Without such basic research no substantial achievement in the academic field of coal geology can be expected.

Basic geological research in coal should explore the nature of the coal material as a substance fundamentally geological both in its origin and subsequent history. Although differences among coals can be described to a certain extent in physical terms, it is generally true that unless differences can be described in chemical terms their actuality is open to serious doubt.

It would be very unfortunate indeed if the suggestions that have been made should be interpreted as indicating that the geological approach provides a short cut to an understanding of the chemical constitution of coal and a bypassing of the methods of analytical chemistry. The significant aspect of the proposal is that the chemical investigations should be carried on in such a way that the geological factors that produced the various types and ranks of coal become a part of the chemical concepts. First, the nature of the geological factors will have to be determined, analyzed, and evaluated as to their probable influence on the chemical structure of coal. Whether or not this naturalistic geological approach to the problem can contribute any assistance to the solution of the central problem of the constitution of coal remains to be determined.

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# Coal Geology Laboratory To Be Established

' WASHINGTON, April 15 — A new coal geology laboratory intended to facilitate geologic studies of the Nation's coal resources soon will be established by the U. S. Geological Survey at Ohio State University, it was announced jointly today by Dr. W. E. Wrather, Director of the U. S. Geological Survey; Dr. Edmund M. Spieker, head of the Department of Geology, Ohio State University; and Dr. John H. Melvin, State Geologist of Ohio,

Space for the new laboratory has been provided by the Department of Geology of Ohio State University in Orton Hall, which also houses the Ohio Geological Survey. Arrangements are now in progress for modifying the building and installing equipment in rooms adjacent to the Edward Orton Memorial Library, which is one of the largest and most complete geological libraries in the United States. The laboratory will be ready for occupancy by the summer of 1949.

In discussing the laboratory and the work of the U. S. Geological Survey on coal and coal reserves, Dr. Wrather pointed out that although many laboratory techniques are available to students of coal, these techniques have never been fully employed by geologists who work directly with the coal beds in the field. The new geology laboratory is intended to bring together the field and laboratory phases of coal investigations.

The main objective of the new laboratory will be to conduct research on the fundamental nature of the fossil plants that compose coal. It is expected that knowledge of the original composition and present nature of the great variety of individual plants and plant fragments in coal will explain observed variations in its physical properties. In combination with the field investigations, these studies should aid in the delineation of coal deposits that are suited for special purposes, such as conversion to synthetic liquid fuels, or the manufacture of coke. The laboratory research on the nature of fossil plants in coal will also aid greatly establishing correlations between coal beds in different areas, knowledge of which is important in calculating reserves. Eventually it is hoped that these studies will permit an improvement in coal classification, consistent with physical and chemical properties, that will take into account the many different kinds of coal.

"There is a growing need", Dr. Wrather said, "for more precise standards to be used in describing and mapping coal deposits, and in estimating reserves of coal for specialized uses. The investigations of the new coal geology laboratory will do much to aid field geologists of the U. S. Geological Survey in attaining these objectives."

# The Earth Sciences - 1949

# Krug Stresses Urgent Need For Conservation

WASHINGTON, March 28—An all-out program for conservation of America's natural resources, and discovery and development of new resources, in order to maintain national strength for war or peace was recommended by Secretary of the Interior J. A. Krug today in his annual report to President Truman.

Warning of an alarming shortage of some vital natural resources, Secretary Krug proposed a series of long-term investments by the government to assure future energy and mineral supplies for American industry. His recommendations included:

Rapid development of synthetic liquid fuels from shale and coal by private industry with government encouragement.

Employment of every available geologist to speed up discovery of new mineral resources in the United States and Alaska.

Restrictions — on the use of scarce basic minerals such as copper, lead and zinc, "to protect the Nation's economy from the effects of critical shortages."

"Events of the past year", Krug said in the foreword to his report, "have demonstrated that America faces—at best—a period of restless and uncertain peace, constantly harassed by the possibility of war. Under these circumstances our chances for survival rest upon our strength. Our strength, in turn, will be measured by our natural resources and our ability to use them efficiently and wisely.

"This will be true, in the long run, whether we have war or peace. Our great industrial machine, the basis of our national strength, cannot function without a steady flow of the greatest stream of power and raw materials the world has ever seen. Two great wars and generations of profligate waste have eaten into our natural resources and begun to exhaust many of them."

Krug's report traced the progress made within the past 16 years in conserving and developing natural resources, but warned that our demands have expanded so rapidly that we are continuing to use up our resources faster than we discover or develop new ones.

As an example of "dollars and cents figuring", Krug's discussion of energy supplies noted that we are using our scarcest fuel-oilmore liberally than our more plentiful fuels such as coal, or inexhaustible energy supplies such as waterpower. He said it is "a matter of concern to the Nation" that oil is the fuel upon which we depend to run our automobiles, our tractors, our airplanes and our ships. If the trend toward oil continues, he said, "our domestic petroleum supplies may be depleted far more rapidly than otherwise."

## Alaskan Peninsula Is A Possible Petroleum Source

WASHINGTON, April 1—Publication of a map showing preliminary results of petroleum investigations in the Iniskin Peninsula, Alaska, was announced today by Director W. E. Wrather of the

U. S. Geological Survey.

The Iniskin Peninsula, on the west side of Cook Inlet about 150 miles southwest of Anchorage, is in the northern part of a large area of Mesozoic rocks that may have some promise for commercial production of petroleum. Seepages of high-gravity oil have long been known on the Iniskin Peninsula. Several shallow wells were drilled there in the period 1898-1906, and a well 8,775 feet in depth was completed in 1939. Shows of oil and gas were reported in some of the wells, but petroleum has not been produced commercially.

Investigations on the Iniskin Peninsula by L. B. Kellum and Helmuth Wedow, Jr., in 1944, and by C. E. Kirschner and D. L. Minard in 1946, resulted (1) in the recognition on the Iniskin Peninsula of Lower Jurassic rocks assigned to the Kialagvik formation as defined in the Wide Bay area to the south, (2) in the differentiation of several subdivisions of the Middle and Upper (?) Jurassic Tuxedni formation and Upper Jurassic Naknek formation. (3) and in the recognition and delineation of faults and anticlinal structures that offer traps for petroleum accumulation.

The data, published on a single sheet measuring 39 by 53 inches, include a geologic map of the

Iniskin Peninsula printed on a scale of 1 inch = 4,000 feet, eight structure sections, four columnar

sections showing character of rocks, and a descriptive text.

The map, titled "Geology of the Iniskin Peninsula," by C. E. Kirschner and D. L. Minard, has been published as Preliminary Map 95 of the Oil and Gas Investigations series, Copies may be purchased from the Director, U. S. Geological Survey, Washington 25, D. C., at 75 cents each.

# Mobilized Electronic Equipment Aids Contour Mapping

PHILADELPHIA, April 2 (Science Service)—A car and a trailer with electronic equipment are used by scientists of the Sun Oil Company to replace the old-type land surveyor and his transit. The combination makes the job of determining elevations needed for contour mapping of large tracts of land both speedy and easy.

The heart of the new surveying equipment is an elevation meter, described by its inventors, Ford L. Johnson and Fred M. Mayes of Sun Company, as a complex electronic integrating mechanism. It is an automatic measuring instrument, mounted in the trailer, that keeps a running record of the dips and rises in the land surface over which the trailer runs.

The trailer transporting the instruments which comprise the elevation meter is a three-wheeled affair. Two wheels on its left side follow exactly in the track of the towing car or truck. The third wheel, on the right side merely serves to balance the trailer.

Measuring instruments are attached to the left-hand wheels. An odometer measures the distance travelled. A pendulum records the inclination of the trailer. As the car and the trailer proceed along

a route, both the distance-measuring counter and the angle-measuring unit send electrical signals from the trailer to an electronic calculator in the automobile.

In the search for new oil deposits, the elevation meter is used in conjunction with a gravity meter, an instrument long used in oil prospecting to obtain information relative to probable underground geological formations. In this application, the elevation meter provides correction for differences in elevation at which gravity meter readings were taken. Another use of the meter is in the production of topographic maps.

# Close Inbreeding Possible Cause of Rapid Evolution of Elephants

LCNDON, April 7 (Science Service)—The paradox of elephant evolution—how animals with the slowest breeding rate have yet had the swiftest history of the rise and decline of new species—may be explained by their close inbreeding habits, suggests Chapman Pincher, a London zoologist.

Elephants are known to live in small herds, each dominated by a single male, with father-and-daughter mating a common practice, Mr. Pincher points out in the journal, Nature. This would give maximum chances for the perpetuation of a new mutation, or sudden evolutionary change, even if this was of the type that required matching with another similar gene in order to survive into the next generation.

In the relatively short geologic time during which the elephant stock has existed on earth, Mr. Pincher states, there have been 300 different elephant species, of which only two now survive.

A similarly rapid evolutionary history marked by close inbreeding, he further points out, is shown by the deer and horse groups, and possibly by the pre-human ancestors of man.

# Michigan Aeromagnetic Survey Released

WASHINGTON, April 11 — A series of 45 aeromagnetic profiles and accompanying map and report of parts of Baraga, Houghton, and Iron Counties, Michigan, have been published by the U. S. Geologic Survey. These profiles, covering 800 square miles, are the first results of an aeromagnetic survey of 2,200 square miles of the iron ore district in the central part of the Northern Peninsula of Michigan.

The north-south profiles, 50 miles long and a quarter-mile apart, show a striking series of long parallel east-west anomalies which have been correlated with known local geologic features. Of particular interest are many sharp negative anomalies which have been found to be caused by dikes of diabase that are strongly magnetized in a direction opposite to that of the earths' magnetic field. A series of strong positive anomalies in the central area where exposures are poor may be caused by plunging folds of magnetic slate similar to that occurring with the iron formation in the Iron River District, in the southern part of the surveyed area.

The profiles and report have been released as Geophysical Investigations, and may be purchased from the Director, U. S. Geological Survey, Washington 25, D. C., for 30 cents.

# New Geologic Map Series Initiated By U. S. G. S.

WASHINGTON, April 14—Publication of the first maps in the new series "Geologic Quadrangle maps of the United States", was announced today by W. E. Wrather, Director of the U. S. Geological Survey.

The new series of quadrangle maps replaces the earlier folios of the Geologic Atlas of the United States, published by the Geological Survey from 1894 to 1945. Maps of the new series will consist of multicolor geologic maps, supplemented as required by structure sections, columnar sections, and other graphic means of presenting geologic data, and a brief explanatory text. Complete geologic descriptions and detailed interpretations of most of the areas shown in these maps will be published later as bulletins and professional papers of the Geological Survey. Where several types of geologic data are to be presented, separate sheets showing economic, surficial, or engineering geology of the same quadrangle will be published in the Geologic Quadrangle Map series. Each map will be issued in two forms: flat, for filing in map cases; and folded, for use in the field.

# "Earthquake Weather", Moon Eclipse May Influence Tremors

BERKELEY, Calif., April 18 (Science Service) — "Earthquake weather" and even the influence of the moon might be studied by scientists trying to learn more about quakes such as the one which rocked the Northwest on April 13,

These suggestions were made at a meeting of earthquake scientists here by Prof. G. E. Goodspeed, head of the department of geology at the University of Washington. Dr. Goodspeed missed the Seattle earthquake because he was on his way to the meeting of the Seismological Society of America here.

He explained that "earthquake weather" which often occurs in California comes when a low pressure area moves in, lowering the barometric pressure. This makes a difference of thousands of pounds of pressure per square foot. It might be "the straw that breaks the camel's back" in setting off a quake, he suggested.

The eclipse of the moon on the night of April 12, hours before the tremor, points up the need for considering any possible relationship between the moon and earthquakes, Dr. Goodspeed contended.

Geologic cause of the Northwest's quake, however, was a fault in the earth east and parallel to the Olympic Mountains, the University of Washington geologist said.

The fault, tens of millions of years old, lies a 1,000 feet below glacial deposits laid down 10,000 to 20,000 years ago. These deposits have made it difficult to study the fault, but it may compare with the famed San Andreas fault, which gets the blame for many of California's worst shakings.

# Aftershocks Come When Earth Creeps Back After Tremor

BERKELEY, Calif., April 18 (Science Service) — Aftershocks which follow earthquakes such as the one which struck the Northwest on April 13 are caused by the earth creeping back into place after the "snap" of the quake.

This new theory of quake aftershocks was given here by Dr. Hugo Benioff of the California Institute of Technology at a meeting of the Seismological Society of America here.

After a tremor the earth is something like a stretched plastic belt creeping back into place, Prof.

Benioff said.

The "snap" of a quake may not come until years after the strain begins. During the intervening time, warping occurs. Then, after the quake, the earth slowly creeps back into approximately the place it started.

This creeping, which brings aftershocks, may continue for many

months after a quake.

# Caves and Mines May Not Protect Against Bombs

BERKELEY. Calif., April 22 (Science Service) — Caves and mines may not be adequate protection against stresses caused by "known and projected bombs and guided missiles," George A. Kiersch of the U. S. Corps of Engineers, Sacramento, told a meeting of the Cordilleran section of the Geological Society of America here.

Mr. Kiersch stressed that his opinions are his own and not necessarily views of the Corps of

Engineers.

He said that detailed scientific surveys are needed to determine where and how best to construct subterranean installations strong enough to resist the new weapons.

Such installations cannot be built in just any kind of rock formation, he pointed out. Consideration must be given to inherent weaknesses in the rock, possible active stresses, ground water level and water supply requirements. He feels any relocation of industry underground would be only a small percent of a nation's national production. The idea of great cavernous areas underground does not agree with geological engineering feats. Such structures would have to be based on the same principles as mines or caves: greater the space, greater the stress from over-loading.

If a bomb were dropped on an overloaded area, it might be a second stress which might cause cave-in

Mr. Kiersch stressed that there are many types of rocks with different strengths and other variable factors. Simply going a certain depth underground does not give protection. Some existing mines, caves might be useful, but only if they meet certain scientific specifications, many of which still have to be worked out.

# Chile's Quake Was Deep-Focus Tremor of Major Intensity

WASHINGTON, APRIL 23 (Science Service)—Chile's destructive earthquake, on April 19, centered in the midst of the area where life and property losses were greatest, U. S. Coast and Geodetic Survey seismologists reported here.

The epicenter was in latitude 37 degrees south, longitude 72.5 degrees west. This is a point between the cities of Concepcion and Chilien, and about 250 miles south of Santiago.

It was a deep-focus quake, with the actual rock break between 40 and 45 miles below the surface. It was also a shock of major intensity, with a magnitude of seven and one-quarter, on a scale that stops at eight and one-half.

# Atomic Energy in Relation to Geology

SUMNER T. PIKE

United States Atomic Energy Commission

Excerpts from an address presented by Commissioner Sumner T. Pike at the Annual Meeting of the American Association of Petroleum Geologists, The Society of Economic Paleontologists and Mineralogists, and the Society of Exploration Geophysicists, St. Louis, Missouri, March 16, 1949.

Up until about seven or eight years ago there had been no search for uranium as such. The only point in hunting for it was that uranium always contains a certain proportion of radium which is an intermediate nuclear decay product of uranium. The uranium salts which resulted from radium refining were customarily wasted or stockpiled except for a very small outlet to certain ceramic and photographic industries. During the war these stockpiles and others which had accumulated as a result of vanadium production on the Colorado Plateau turned into a great asset for us and our allies, and an intense, not to say frantic, search was conducted for uranium with considerable secrecy notable lack of success throughout the then available parts of the world. Since the war's end this search has been conducted on an open basis, again with no particular success, but will be continued and expanded until, we all firmly hope, extensive medium or high grade deposits of uranium are discovered.

The types of uranium occurrence that are now known were practically all described in the literature more than twenty-five years ago, but let us take a quick glance at a few of the things of great interest which are not known and which we should know.

- 1. The best high grade uranium deposits are in pre-Cambrian shield areas. The first one of these might very well have been accounted for by mere chance and the second possibly by coincidence, but when the third one shows up one is inclined to think that a habit is indicated.
- 2. No one has any plausible explanation why uranium and thorium show in considerable concentrations while still only making up a few parts in a million of granites or pegmatites.
- 3. The basic mineralogy of uranium occurrences in shales, phosphates and other marine sediments is still almost entirely unknown. This is equally true of the Colorado carnotites which are probably secondary replacement deposits in the Morrison formation in the Colorado Plateau. This same formation produces oil in considerable quantities somewhat further north.
- 4. There has been a lot of speculation but no solution on the problem of the relationship between helium gas wells and uranium deposits. Helium is one of the products of uranium decay and the question of what these helium wells means is important to us.

The Atomic Energy Commission would welcome suggestions as to research or exploration methods which might be used. The regional geologist who covers a lot of country whether by foot, horseback, car, or plane, very frequently sees

things which are outside of his specific assignment. We hope that we can depend on those of you who perform this function to learn a little something about what uranium occurrences look like and let us or some of the mining people know if you see anything that looks interesting.

The geologist who works on location can at times help solve some of the problems of uranium occurrences by testing radioactivity of samples, particularly cores and cuttings, since there is always the chance that concentrations in shales may turn out to be high enough to have commercial possibilities. In areas where gas containing any appreciable percentage of helium is found, we would like to know something about the radioactivity in the underlying igneous rocks.

The fact is that up to date this country appears to be very poor in uranium resources and that it will be immensely to our nation's advantage not to neglect any possibility which might result either in a substantial discovery or in a better understanding of the factors which govern uranium deposits.

The second area where atomic energy is already being of some importance in exploration for petroleum lies in the use of radioactivity as a tool. You are already familiar with the use in well logging of the natural radioactivity in the strata penetrated by the drill, This is pretty close to standard practice and needs no further comment.

You are probably also thoroughly aware that accurate and delicate measurement of the rate of flow of underground reservoirs can be made by the introduction of certain artificially radioative elements or compounds. An obvious modification of this latter procedure is a measurement of the differential rate of flow, let's say of oil and salt water through sands, by means of isotopes which are soluble in the one liquid and not in the other and which give specific signals to indicate their presence.

It seems likely to me, however, that in petroleum exploration as in most other lines where the isotopes are being, or are to be of value, the great use will probably occur in laboratory research where the highly multiplied delicacy or perception possible through application of these radioactive elements can produce qualitative and quantitative answers to problems whose solution has been extremely difficult or impossible by previously known chemical or physical methods.

The third area in which anybody interested in petroleum should obviously be interested is that of power from atomic energy. There is power in nuclear fission. No one who has seen photographs of the explosion of atomic bombs or of the aftermath can have any doubt on this point.

Unless the geologists (and here one has to think primarily of the mining geologists) — unless the geologists and prospectors find us some deposits which will yield low cost uranium, we must, if we have any hope for substantial economical power production from nuclear energy, investigate a process which is sometimes called breeding. This in effect means that for every atom of fuel consumed, we create more than one new atom of fuel, which in its turn can be consumed

with a further creation of surpluses. This process, named in our office "Operation Bootstrap," is theoretically possible but the margin is very slim indeed. Within two or there years we should know whether it is humanly possible to turn this dream into a reality.

# Colo. Uranium Ore Processing Plant To Be Rehabilitated

WASHINGTON, April 24—The U. S. Atomic Energy Commission today announced the signing of a contract with the U. S. Vanadium Corporation for the rehabilitation and operation of the Corporation's uranium-vanadium processing plant at Uravan, Colorado.

Under the terms of the contract, the U. S. Vanadium Corporation has agreed to rehabilitate the plant and the company-owned townsite and install new equipment and facilities for the recovery of uranium. The Commission has agreed to purchase the mineral production of the plant at a guaranteed unit price until June 30, 1954.

The purpose of the contract is to assure operation of the plant for the period covered by the Commission's Domestic Uranium Program Circular No. 5, which became effective February 1, 1949. The Circular established a guaranteed minimum price for the uranium ores of the Colorado Plateau area until 1954.

The Uravan plant is expected to be ready for operation about the end of this year. In the meantime, the U. S. Vanadium Corporation will secure ore through production from its own mines and through purchases from other producers at the prices described in Circular No. 5. Such a program provides a new market for the independent miners of the area.

Part of the ore supply for Uravan will also come from mining properties in the Calamity, Colorado, area which were acquired by the Government during the war. The lease of these claims to the U. S. Vanadium Corporation on a royalty basis is provided for in the contract.

The signing of the new contract completes arrangements for the operation of all five of the existing uranium-vanadium ore-processing plants in the Colorado Plateau area, On April 11, 1948, when the Commission announced its Domestic Uranium Program, only two of the plants were in operation—one at Naturita, Colorado, owned by Vanadium Corporation America, and one at Rifle, Colorado, owned by the U.S. Vanadium Corporation. Since then, the plant at Durango, Colorado, has been placed in operation under Commission ownership, and the plant at Rifle has expanded production and begun ore purchases from independent miners in the area. The plant at Monticello, Utah, has been purchased by the Commission, and is now being redesigned and improved. It is expected to be in operation by July.

As a result of this program, the Commission expects the uranium-vanadium mining and processing operations on the Colorado Plateau to be sustained at or above the highest level ever reached.

# New List of Geologic Map Symbols Prepared

A new list of map symbols has recently been tentatively adopted for use in publications of the U. S. Geological Survey. This list was prepared by the Geologic Map Symbol Committee of which Dr. E. N. Goddard is chairman. Also serving on this committee are Drs. Ernst Cloos, Lewis B. Pusey, and W. W. Rubey.

"It has been the aim to assemble, insofar as possible, symbols that experience has shown are widely needed. Most of these in the list are symbols that are now in common use. It is realized that other symbols will be needed for many special field problems, but it is hoped that the new symbols devised will be as consistent as possible with those on the list. This list is a revision of an earlier one adopted more than 10 years ago by the Geological Survey. The revisions have been made in response comments by both Survey geologists and others throughout the country and the committee has attempted to bring about greater consistency.

"In the use of line symbols for contacts, faults, and folds the solid line is used throughout to denote accurate locations, the dashed line for approximate or indefinite locations, and the dotted line for concealed locations.

"Different kinds of arrows are used to distinguish the various types of linear structures. The barbed arrow is used for flow lines, alinement of minerals and inclusions, etc., and it can also be used for other special types of lineations if such uses are indicated in the explanation on the map. The half-barbed arrow is used to denote direction of relative movement; the spear-point is used for slicken-

sides, grooves and striations; and the triangular arrow is used for axes of folds."

The Map Symbol Committee decided to adopt the term *plunge* for the angle measured in the vertical plane and to abandon the term *pitch*, suggesting the use of the term *rake* for the angle measured in the plane of the structure.

"Though this list of map symbols have been prepared primarily for use in publications of the U. S. Geological Survey, it is hoped that it will be helpful to all geologists and will eventually bring about a general uniformity of usage. Copies may be obtained free of charge from the Geologic Map Editor, U. S. Geological Survey, Washington 25, D. C."

# FILM ON PEAT-MOSS INDUSTRY RELEASED

QUEBEC, April 4—A 16-mm. sound film in natural color that illustrates our peat production development, the products obtained from it, and the uses to which it is applied has been released by the Cine-Photographic Branch, in collaboration with the Quebec Department of Mines.

The Province of Quebec has become an important producer of peat-moss since the beginning of the last war. When it became impossible to import this product from Europe into Canada and the United States, an active exploitation of local deposits was undertaken and several plants have since commenced production in various parts of the Province.

The film may be obtained by applying to the Cine-Photography Branch, Parliament Buildings, Quebec, Canada.

# Mineral Problems Discussed By Mines Director

With only seven percent of the world's population, the United States uses 70 percent of all the oil produced on the globe and 50 percent of all the minerals, according to James Boyd, Director of the U. S. Bureau of Mines, In addition, the United States does 40 percent of the world's work through the use of energy obtained largely from mineral fuels, he said.

In an address scheduled to be given before the Northeast Chapter of the Pennsylvania Society of Professional Engineers at Scranton, Pa., on May 14, Dr. Boyd pointed out a number of weak spots in the American minerals picture and outlined what is being done by Government and industry to restore full economic security in this field.

"Despite our own increasing output, our self-sufficiency in minerals is declining," Dr. Boyd stated. As an example of the rapid rate of increasing mineral production in this country, he noted that "we are today producing three times the *physical volume* of mineral commodities that we produced in 1910, the year the Bureau of Mines was established."

To keep pace with increasing consumption, America must extend and develop domestic reserves of ore and in many instances replace materials that eventually will become insufficient for our needs, Dr. Boyd said.

"Fortunately, our native inventive genius has in the past provided new materials to supplement the old," the Director said. "There is absolutely no reason to believe that we will not continue to progress as our research laboratories

develop new technology. One objective of the Bureau of Mines is to anticipate demands in this field so that new materials will be developed and ready when needed to replace those less easily obtained."

Devoting a large portion of his remarks to the subject of mineral fuels — coal, petroleum oil shale, gas, synthetic products, and others -Dr. Boyd concluded that "it is obvious that the country eventually must anticipate the use of coal as the primary source of our fuels." mineral Although United States has much larger coal reserves than either petroleum or natural gas, at the present time an increasing proportion of energy is coming from oil and gas, he noted.

Through research in the production of synthetic liquid fuels from coal and oil shale, the Bureau of Mines hopes to help improve the situation in this respect, Dr. Boyd said. He described how the Bureau, in cooperation with industry, is also experimenting with the underground gasification of coal to obtain gases for generating electric power and raw materials for synthetic liquid fuels. If successful, this experiment may prove "a boon" to conservation and to the industry, he added.

Wasteful mining—leaving a considerable percentage of the coal underground — was described by Dr. Boyd as one of the most pressing problems to be solved by the mining industry. In Europe, he said, 100 percent removal of coal is a forced objective. The Bureau of Mines is attacking this problem by studying different mining methods and making recommendations to industry.

Aside from research in synthetic fuels made from coal, an enormous amount of work is going on in industry and in Bureau of Mines laboratories to encourage greater utilization of coal in its natural form, Director Boyd pointed out. For instance, the Bureau is investigating the composition and nature of various types of coal to determine the most efficient uses in burning under boilers for producing energy, in raising steam for generating electricity, in utilizing the fuel directly in space heating. and in other industrial uses.

Illustrative of the problem of declining self-sufficiency in certain metallic minerals, Dr. Boyd cited the critical nonferrous metals, copper, lead and zinc. Before the first world war. America's surplus production was exported, he said, but now it has become necessary to increase the *imports* of these critical materials repeatedly to meet our industrial demands. Chromite another important mineral wherein we are depending upon foreign supply to meet our industrial requirements. We must intensify exploration of these metals in the United States, he said, and develop the maximum reserves possible.

In addition to discovery, metal reserves are being extended by advances in the technology of extracting lower-grade ores at a profit, and by improving beneficiation and metallurgical processes that permit the use of these lower-grade materials, Director Boyd added. He described how the Bureau of Mines is pursuing a broad research program in mining and metallurgy to assist the industry in solving many of the knotty problems.

Speaking of titanium, a new metal developed by the Bureau of Mines, Director Boyd said:

"A dramatic recent development is that of the metal titanium, the future of which is difficult to predict. Here is a material that is abundant in the earth's crust, has extraordinary structural possibilities, and may well have an important bearing on our future use of metals. Perhaps it is in the same stage of development today that aluminum was 75 years ago. The Bureau of Mines pioneered successfully in the research and pilot-plant work on titanium, and just this last year, industry began to take up production of the metal itself."

# A. F. M. S. Sponsors Earth Science Contest

Youngsters will be awarded valuable prizes for original articles on the earth sciences in the first of a series of contests sponsored by the American Federation of Mineral-ogical Societies.

A \$25 Savings Bond and a fine mineral specimen will be the first prize. Additional prizes will include specimens, equipment, and books appropriate to the interests of the winners.

The contest is open to boys and girls in the United States and Canada under twenty, who have not yet enrolled in a college or university. Original articles will be accepted on any subject connected with the earth sciences.

Papers should be submitted before October 15 to Prof. Richard M. Pearl, Colorado College, Colorado Springs, Colo. The judging will be done by three professional men who are much concerned with earth science education. The Judges are Arthur L. Flagg of Phoenix, Ariz., Dr. Ben Hur Wilson of Joliet, Ill., and Orlin J. Bell of Oakland. Calif.

# Annual Conclave of American Gem Society Held in Boston



Everett M. Smith
Dr. Edward H. Kraus, Dean Emeritus,
College of Literature, Science and Arts,
University of Michigan, and Dr. Charles
Palache, Professor of Mineralogy, Emeritus,
Harvard University.

The Fourteenth Annual Conclave of the American Gem Society was held in Boston on April 2-5, 1949. Included among a distinguished list of conclave speakers were Drs. Henry F. Donner, Ralph J. Holmes, Cornelius S. Hurlbut, Jr., Edward H. Kraus, Frederick K. Morris, and Charles Palache. The New England Guild of the American Gem Society served as hosts to the Conclave, William S. Preston was elected to the chairmanship of the International Committee. Kenneth G. Mappin was elected Vice-Chairman.

The "Gemprinter", a micrographic camera, which takes pictures of the magnification of a light-colored transparent gemstone (under a magnification of 10 times), was exhibited for the first time at the conclave. Accompanying the print, data on its size, weight, location of flaws, color, etc., are inserted on a strip of paper at the side of the instrument. When the photo is taken, this information is printed next to the magnified image of the stone.



Dr. Henry F. Donner (center), Western Reserve University, explains the use of the petrographic microscope for the identification of gems to (left to right) A. R. West, Robert M. Shipley, Jr., Charles Carolyne, Robert Crowningshield, Earl E. Jones, and Richard T. Liddicoat, Jr.



The Gemprinter

# New Books

INTRODUCTION TO HISTORICAL GEOLOGY — by Raymond Cecil Moore. 1949. 582 pp., 386 illus.; \$5.00. (McGraw-Hill Book Co., Inc., New York.) This new text is concerned primarily with the nature of changing physical conditions and the record of life during geologic history in North America, although some attention is paid to areas of interest in Europe. Unfamiliar technical terminology is purposely avoided in the text, with the emphasis on a clear explanation of principles and a graphic presentation of the most significant data.

The introductory chapters deal with general principles, evolution, and the origin of the earth. They make an excellent background to the following chapters and serve to help the reader understand clearly the meaning and significance of historical geology. Particularly interesting is the chapter on the evolution of life.

Perhaps the most outstanding feature of the new book is the abundance and excellent selection of illustrations, mostly new, and all well described. Of particular merit are the large number of animal restorations.

An appendix is devoted to the characters of some animal groups represented among fossils. The book is concluded with an extensive index of 46 pages.

CLIMATIC ACCIDENTS IN LAND-SCAPE MAKING — by C. A. Cotton. 1948. 354 pp., 59 pls., 149 figs.; \$7.00. (John Wiley & Sons, Inc., New York. Printed in New Zealand). This work is a sequel to "Landscape as Developed by the Processes of Normal Erosion". It is a study of the processes which alter the normal movements of geomorphic cycles. The two sections of the book represent the two major types of climatic landscape accidents: the first being "Dry and Dry-Seasonal Climatic Landscape Types"; the second devoted to "Glaciated Landscapes". The influence of these interruptions on later formations and on the later interpretations of those formations is profound.

All of the apparently valid theories and observations have been presented by the author, and tentative conclusions have been offered.

118 photographs illustrated clearly the various types of landscape, with the emphasis on glacial cirques and troughs.

Geologists will find this study to be an indispensable addition to their libraries.

FIELDBOOK OF NATURAL HIS-TORY - by E. Laurence Palmer. 1949. 664 pp., illus.; \$5.00. (McGraw-Hill Book Co., Inc., New York). This profusely-illustrated volume is meant to serve as a guide to almost every field of nature study - and does an especially creditable job with the plant and animal kingdoms. Short sections on astronomy and "the mineral kingdom" are included - each being 19 pages. 33 mineral, species described, accompanied by 33 photographs, most of which could have been omitted or substituted for by good line drawings. The remaining pages of the mineral kingdom are divided into the following: atmosphere, hydrosphere, and loose mantle materials; unconsolidated materials; sedimentary rocks; metamorphic rocks; and igneous rocks.

GEOLOGY OF BEATTY TOWN-SHIP (Vol. LVI, Part VII, 56th Annual Report, Ontario Dept. of Mines, Toronto, Ontario) by J. Satterly and H. S. Armstrong. 1949. 34 pp., 9 illus.; free. A comprehensive review of the geology of the area is covered by this report, and a colored geological map on the scale of I inch to 1.000 feet accompanies it (No. 1947-2). The report indicates that gold is the only metal of economic importance that is known to occur in Beatty Township, and it is pointed out that almost every outcrop has been visited by the prospector. Geophysical surveys have been used to prospect driftcovered areas. The consolidated rocks are all pre-Cambrian and are mantled by extensive deposits of Pleistocene clay and sand. The major structure in the sediments and volcanics is a faulted syncline with both limbs exposed. The rocks of the area are broken by complex faulting and fracturing into a great number of blocks.

ANCIENT **FORESTS** OF OREGON - by Ralph W. Chaney. 1948. 56 pp., 19 pls.; \$1.00. (Oregon State System of Higher Education, Eugene, Oregon). This interesting little book is devoted primarily to the Oregon forests of the Cenezoic era. It is brought up to date by the inclusion of the findings of the living redwoods in China which were similar to the fossils redwoods of Oregon, and the discovery in the John Day Basin of the first evidence of the occurence of leaf impressions in the Rattlesnake formation. The fossil redwoods of Oregon are here interpreted in terms of their Chinese descendants. Both localities and plants are illustrated by nineteen plates.

REPORT OF THE COMMITTEE ON A TREATISE ON MARINE ECOLOGY AND PALEOECOLOGY, 1947-1948 (Division of Geology & Geography, National Research Council, Wash-

ington, D. C.) - Harry S. Ladd, Chairman. 1948. 117 pp., 7 figs.; \$1.00. Included in this report is the paper "Paleocology of the Early Ordovician Sea in Central Texas" by Preston E. Cloud, Jr. and Virgil E. Barnes. They have attempted to correlate the observed lithologic and biologic features of the Lower Ordovician rocks of central Texas with an existing environment. This rock sequence, the Ellen-burger group, is entirely of limestone and dolomite. It is concluded that the sublithographic limestones of this group originated as chemially precipitated calcium carbonate muds such as the aragonite muds today forming west of Andros Island on Great Bahama Bank.

Also covered in the report are current activities, recent publications, annotated bibliographies, and three shorter papers: Environmental Conditions of Deposition in the Gulf of Mexico by Parker D. Trask; Recent Shallow-water Foraminiferal Assemblages from Nugata Prefecture, Japan by T. Oinomikado and Leo W. Stach; and Foraminiferal Thanatocoenoses of Ago Bay, Kii Peninsula, Japan by Masao Morishima.

### ASSOCIATION OF GEOLOGY TEACHERS ELECTS OFFICERS

The ninth annual meeting of the Association of Geology Teachers was held at the University of Chicago, in Rosenwald Hall, April 22 and 23, with forty members and guests in attendance. Officers for the coming year were elected as follows:

President—C. L. Bieber, De Pauw University

Vice-president—Paul R. Shaffer, University of Illinois.

Secretary-Treasurer—Katherine F. Greacen, Milwaukee-Downer College.

Editor—Percival Robertson, The Principia College.

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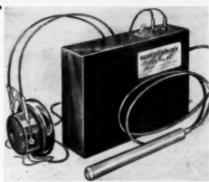
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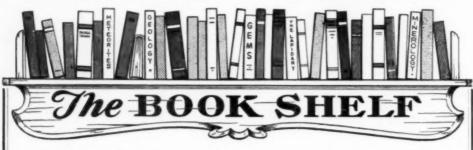
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